Optical pick-up apparatus for multi recoding/reproducing

[Technical Field]

The present invention relates an optical pickup apparatus. More particularly, the present invention relates to an optical pickup apparatus which is capable of recording/reproducing information on/from recording media having different formats by employing a dual wavelength laser diode and a hologram element.

[Description of Related Art]

An optical pickup apparatus is employed in a compact disk player (CDP), a digital versatile disk player (DVDP), a CD-ROM driver, and a DVD-ROM to record/reproduce data on/from a recording medium in a non-contact manner. In a recording mode, an optical pickup projects laser beams onto a surface of an optical disk to thereby form a pit. In a reproducing mode, the optical pickup optically reads out pit information from the optical disk and outputs it in an electric signal form. In order to achieve the above performance, the optical pickup comprises a plurality of optical members, such as a laser diode for emitting laser beams, a diffraction grating, a beam splitter for adjusting deflection of the laser beam, a plurality of lens for forming a light path, and a sensor for detecting a signal.

If the optical pickup apparatus is employed in the DVDP that is capable of high-density recording/reproduction, it has to be compatible with a compact disk (CD) or a CD-R (Recordable).

However, the DVDs have a standard thickness that is different from that of the CDs because of an allowable error of mechanical disk slope and numerical aperture of object lens.

The thickness of CD is 1.2mm, whereas the thickness of DVD is 0.6mm. Regarding a wavelength of a light source for the reproduction, the CD is standardized to 780nm, whereas the DVD is standardized to 650nm. Due to the above differences, a general CDP is not able to reproduce data recorded on a DVD. Therefore, there is a demand for an optical pickup apparatus for DVD that is compatible with a general CD.

FIG. 1 illustrates a conventional optical pickup apparatus which has been developed in order to solve the above problem. Referring to FIG. 1, the conventional optical pickup apparatus comprises a light module 10 having a first light source 11 and a monitor photodetector 13 which are integrally formed therewith, a second light source 20, a photodetector 21 to adjust an amount of light rays emitted from the second light source in a data recording mode, a 1/2-wavelength plate 25 to convert a p-polarized light emitted from the second light source into a s-polarized light ray, a complex prism 30 acting as a polarized light beam splitter to convert light paths of light rays respectively emitted from the first and the second light sources, a collimating lens 40 to convert the light rays emitted from the first and the second light sources into parallel light rays, a reflection mirror 45 to reflect incident light rays, a polarized light hologram element 50 to split a light which is incident to a disk 100 to a plurality of beams, an object lens 60 for focusing the split beams on the disk 100, and a third photodetector 80 for receiving light beams which are reflected from the disk and transmitted through the complex prism 30. One of the first and the second light sources is operated. The first light source is for CD and emits light rays of 780nm wavelength, and the second light source is for DVD and emits light rays of 650nm wavelength.

The polarized light hologram element 50 is designed to operate in response to the wavelength of light rays emitted from the second light source, i.e., in a DVD mode. Also,

the polarized light hologram element 50 operates only in response to the p-polarized light. The polarized light hologram element 50 has a 1/4-wavelength plate formed on a surface thereof opposing to the disk 100 so that the polarized light hologram element 50 converts an incident s-polarized light into a circularly polarized light and converts a reflection light from the disk 100 to the p-polarized light. Only the light containing a p-polarized light, which is emitted from the second light source 20 and reflected from the disk 100, is split into 10 beams by the polarized light hologram element 50.

The third photodetector 80 receives the 10 split beams to thereby obtain data information and error information from the disk 100. The third photodetector 80 comprises a plurality of sensors for detecting light rays reflected from the DVD and one single sensor for detecting light rays reflected from the CD.

Since the conventional compatible optical pickup apparatus as described above aligns optical axes of the lights having different wavelengths by use of the complex prism 30 and achieves a simple optical structure by use of the collimating lens 40, it can provide improved signal regeneration when operating in high temperature (recording and reproducing). However, it is difficult to fabricate the complex prism 30, and a variety of technologies are demanded in assembling the complex prism 30 with the optical pickup apparatus. Also, an assembly tolerance between the object lens 60 and the polarized light hologram element 50 cannot be solved, and the pickup adjustment cannot be achieved due to the splitting of light into 10 beams. Since two laser diodes are used, an optical axis error occurs between the two lights emitted from the two laser diodes. Due to the complicate structure and a great number of assembly parts, the assembliability deteriorates, which causes an inferiority of a product.

Since a power of a laser in a DVD recording mode is stronger that that in a reproducing mode, the optical pickup apparatus is operated at a relatively high temperature. Since inner parts of a pickup head are assembled with one another by UV (Ultraviolet) bond, the connection portions may warp and expand at the high temperature. In this case, the light transmitted through the parts or reflected from the parts deviates from the photodetector, which deteriorates the signal regeneration at the high temperature. In order to solve the above problems, there is a demand for a method for removing unnecessary parts or minimizing the number of beams deviating from the photodetector.

The conventional optical pickup has problems of a lowered productivity which is caused by difficulty in assembling, a reduction of yield, and an increased manufacturing cost which is caused by the great number of optical elements.

[Brief Description of the Drawings]

FIG. 1 is a view schematically illustrating a compatible optical pickup apparatus of the prior art;

FIG. 2 is a view schematically illustrating a compatible optical pickup apparatus according to an embodiment of the present invention;

FIG. 3 is a view showing a hologram module according to the present invention;

FIG. 4 is a view showing configuration of a polarized light hologram of FIG. 3;

FIG. 5 is a view showing split beams focused on an optical disk; and

FIG. 6 is a view showing sensors of a photodetector.

Description of the reference numerals in the drawings

300: dual wavelength laser diode 305: monitor photodetector

310: polarized light beam splitter
320: reflection mirror
330: collimating lens
340: hologram module
350: object lens
360: sensor lens
370: photodetector

[Detailed Description of the Present Invention]

[Technical Object]

The present invention has been developed in order to solve the above problems. An object of the present invention is to provide a compatible optical pickup apparatus having an improved construction which uses a dual wavelength laser diode and a polarized light hologram element for splitting a light which is incident to a disk, into 5 beams, thereby providing a simple optical structure, and solves a tracking error to record data on DVDs of different formats, thereby improving a signal regeneration.

[Technical Solving Method]

In a compatible optical pickup apparatus according to the present invention, a light source module having a first light source for DVD and a second light source for CD which emits light rays of different wavelength operates one of the first and the second light sources which conforms to the standard of a recording medium, thereby emitting a light containing a p-polarized light. A light splitting element transmits a part of the light rays emitted from the light source to a monitor photodetector which monitors a magnitude of the emitted light rays to control of the operation of the light source. The light splitting element reflects the remaining light rays in a predetermined direction so that the light rays are incident to the recording medium. A collimating lens converts the light rays which are reflected from the light splitting element into parallel light rays and makes the parallel light rays incident to a

hologram module. The hologram module splits the incident light into 5 beams, and the respective beams are focused by an object lens to respectively form optical spots on predetermined positions of a recording surface of the recording medium. A photodetector receives the beams which are reflected from the recording medium and pass through the object lens, the hologram module, the collimating lens and the light splitting member, thereby providing a information signal and an error signal. A sensor lens is arranged on a front surface of the photodetector for adjusting the light rays reflected from the recording medium to be incident on the photodetector with a predetermined size.

The hologram module comprises a polarized light hologram formed in a circular pattern and splitting only predetermined polarized light rays, and a 1/4-wavelength plate arranged on a surface of the polarized light hologram opposite to the object lens for turning a phase of the polarized light rays by 90°.

Preferably, the polarized light hologram is divided into a first hologram and a second hologram which are operated in response to the light rays emitted from the first light source. The first and the second holograms are formed on the same plane in a semicircular shape and located one on the other. The first and the second holograms diffract the light by a predetermined angle with respect to an optical axis of the light to thereby generate zero-order and ±1 order beams.

Preferably, the zero-order beam generated by the first and the second holograms is focused by the object lens on a predetermined position conforming to the standard of a DVD-ROM.

Preferably, the –1 order beam generated by the first hologram and the +1 order beam generated by the second hologram are focused by the object lens on predetermined positions

conforming to the standard of a DVD-R/DVD-RW.

Preferably, the +1 order beam generated by the first hologram and the –1 order beam generated by the second hologram are focused by the object lens on predetermined positions conforming to the standard of a DVD-RAM.

The photodetector comprises 5 DVD sensors which correspond to the respective five split beams and are arranged apart from one another by a predetermined distance.

If a DVD-ROM is used for the recording medium, a focus error signal and a tracking error signal generated at the photodetector by the astigmatism method and by the DPD (Differential Phase Detection) method, respectively, are calculated with respect to a signal of the zero-order beam which is reflected from the DVD-ROM and received at an associated DVD sensor.

If a DVD-RAM is used for the recording medium, a focus error signal generated at the photodetector by the DAD method and a tracking error signal generated at the photodetector by one of the DPP and the PP (Push Pull) methods are calculated with respect to a signal of the zero-order beam reflected from the DVD-RAM, a signal of the +1 order beam generated by the first hologram, and a signal of the –1 order beam generated by the second hologram, which are received at associated DVD sensors.

If a DVD-R/DVD-RW is used for the recording medium, a focus error signal and a tracking error signal generated at the photodetector by the astigmatism method and the DPP method are calculated with respect to a signal of the zero-order beam reflected from the DVD-R/DVD-RW, a signal of the –1 order beam generated by the first hologram, and a signal of the +1 order beam generated by the second hologram, which are received at associated DVD sensors.

If a CD is used for the recording medium, a focus error signal and tracking error signal generated by the photodetector by the astigmatism and the PP method are calculated with respect to a signal of light emitted the second light source which is reflected from the CD and received at the CD sensor.

[Advantageous Effect]

According to the present invention as described above, the optical pickup apparatus is capable of recording/reproducing data on DVDs having different formats by use of a simple pattern hologram, and also compensates for the tilting of optical axes of DVD and CD by use of a dual wavelength laser diode. Also, the assembling and adjustment can be easily achieved by the simple optical structure, a manufacturing cost can be reduced, and a signal regeneration can be improved when the optical pickup apparatus operates in high temperature

Although the preferred embodiments of the present invention have been described, it will be understood by those skilled in the art that the present invention should not be limited to the described preferred embodiment, but various changes and modifications can be made within the spirit and scope of the present invention as defined by the appended claims.

[Best Mode for Embodying the Invention]

Hereinafter, the present invention will now be described in greater detail with reference to the accompanying drawings.

FIG. 2 is a view schematically showing an optical pickup apparatus according to an embodiment of the present invention.

Referring to FIG. 1, an optical pickup apparatus according to an embodiment of the

present invention comprises a light source module 300, a monitor photodetector 305, a light beam splitter 310, a reflection mirror 320, a collimating lens 330, a hologram module 340, an object lens 350, a sensor lens 260, and a photodetector 370.

The optical pickup apparatus according to the present invention is employed in an optical recording/reproducing apparatus (not shown), such as a CDP (Compact Disk Player), a DVDP (Digital Video Disk Player), and a DVDR (Digital Video Disk Recorder), to record data on an optical disk 400, optically read out data from the optical disk 400, convert the read data into an electrical signal, and output the electrical signal. The optical disk 400 is an optical recording medium on which data is recorded, and includes a DVD (e.g. DVD-R, DVD-RW, DVD+RW, DVD-RAM, DVD-ROM) and a CD (e.g. CD-R, CD-RW, CD-ROM). However, this should not be considered as limiting.

The light source module 300 employs a dual wavelength laser diode (LD) and comprises a first light source for a DVD (Digital Video Disc) and a second light source for a CD (Compact Disc) which are integrated in a single case (e.g. can) and emits light rays having different wavelengths. The first light source uses visible rays of approximately 650nm wavelength and the second light source uses infrared rays of approximately 780nm wavelength. The light ray emitted from each light source contains a p-polarized light. In this embodiment, an incident light refers to a light that is emitted from each light source and then is incident to the optical disk 400, and a reflection light refers to a light that is reflected from the optical disk 400 and then is received at the light detector 370.

The first light source is operated when a DVD is mounted in the optical recording/reproducing apparatus (not shown), whereas the second light source is operated when a CD is mounted in the optical recording/reproducing apparatus. The first and the

second light sources are used to record a predetermined signal on the optical disk 400 or read out a signal from the optical disk 400, and are arranged apart from each other by a predetermined distance. Also, the first and the second light sources are configured so that major axes of laser beams are perpendicular to each other with respect to a pitch. Accordingly, in a recording mode, pitches are formed along a track direction more accurately. Hereinafter, description will now be made about a case that data is recorded/reproduced on/from the DVD when the first light source is operated.

The monitor photodetector 305 receives light rays emitted from the first light source and transmitted through the light beam splitter 310 and detects an amount of the light rays. The light emitted from the first light source for recording data on the DVD has a magnitude of approximately 10mW and the light for reproducing the data has a magnitude of approximately 1mW. The monitor photodetector 305 monitors the emitted light rays and controls the magnitude thereof.

The light beam splitter 310 acts as a polarized light beam splitter and uses a cubic to transmit a part of incident polarized beams and reflect remaining polarized beams in a predetermined direction. The cubic is designed to transmit a small amount of p-polarized light rays and send it to the monitor photodetector 305, make most of the light rays incident to the optical disk 400, and transmit all of the s-polarized light rays.

The reflection mirror 320 adjusts a light path so that the light reflected from the light beam splitter 310 is incident to the optical disk 400.

The collimating lens 330 has a predetermined radial angle and converts the light beam emitted from the LD into a parallel beam, and is employed for the purpose of compensating for deterioration of a recording efficiency which is caused by aberration of the

light beams transmitted through a plurality of optical members.

FIG. 3 is a view showing a hologram module. Referring to FIG. 3, the hologram module 340 splits a light into a plurality of beams according to a state of polarization of the light, and comprises a pair of glasses 344a and 344b, a polarized light hologram 345 and a 1/4-wavelength plate 346.

The polarized light hologram 345 is operated in response to only the p-polarized light. If the polarized light hologram 345 is operated in response to the s-polarized light, transmission efficiency deteriorates. The operation of the hologram will be described below.

The 1/4-wavelength plate 346 phase-changes a linearly polarized light by 90° and converts it into a circularly polarized light. That is, the 1/4-wavelength plate 346 converts the p-polarized light transmitted through the polarized light hologram 345 into a left circularly polarized light and converts a reflection light of a right circularly polarized light reflected from the optical disk 400 into a s-polarized light. Accordingly, the hologram is not operated when the reflection light containing the s-polarized light passes through the polarized light hologram 345.

FIG. 4 is a view showing the polarized light hologram 345. Referring to FIG. 4, the polarized light hologram 345 has a circular hologram corresponding to a cross-section of the incident light and is divided into a first hologram 345-1 and a second hologram 345-2 which have a semicircular shape and are located one on the other to form a circular shape. The first and the second holograms 345-1 and 345-3 perform different operations.

Incident light passing through the first hologram 345-1 is divided into a zero-order beam that goes straight through the first hologram 345-1 and ±1 order beams that advance with a predetermined diffraction angle by the operation of the first hologram 345-1.

Incident light passing through the second hologram 345-2 is divided into a zero-order beam that goes straight through the second hologram 345-2 and ±1 order beams that advance with a predetermined diffraction angle different from that of the first hologram 345-1 by the operation of the second hologram 345-2. Since the two semicircular zero-order beams combine into one circular zero-order beam, the incident light passing through the polarized light hologram 345 is split into 5 beams.

In here, the −1and +1 order beams of the first hologram 345-1 are respectively referred to as a second and a fifth beams, the zero-order beam as a third beam, and the −1 and +1 order beams of the second hologram 345-2 to a first and a fourth beams, respectively. The respective diffraction angles are determined depending on a characteristic of the object lens 350 and a kind of the optical disk 400 so that the respective split beams are focused on a predetermined position of the optical disk 400.

The object lens 350 focuses the 5 beams on a predetermined position of the optical disk 400 and performs a focusing servo and a tracking servo by use of an actuator (not shown).

FIG. 5 is a view showing the 5 beams focused on the optical disk 400. Referring to FIG. 5, of the 5 beams, the third beam is focused by the object lens 350 on a third position 400c that conforms to the standard of the DVD-ROM. The second and the fourth beams are focused on a second position 400b and a fourth position 400d. The second position 400b and the fourth position 400d are distanced from the third position 400c by a vertical distance d_1 that conforms to the standards of the DVD-R and the DVD-RW. The first and the fifth beams are focused on a first and a fifth positions 400a and 400e which are distanced from the third position 400c by a predetermined vertical distance d_2 that conforms to the standard of

the DVD-RAM.

The sensor lens 360,which is a concave lens, focuses the split beams reflected from the optical disk 400 on a corresponding position of the photodetector 370 in cooperation with the collimating lens 330, and amends an optical length occurring due to a tolerance

The photodetector 370 is a photodiode integrated circuit (IC) that detects a information signal of the 5 split beams which were reflected from the optical disk 400 and passed through the object lens 350 and the light splitting element 310, a focusing error signal and a tracking error signal, and converts them into electric signals,

The photodetector 370 according to the present invention is a 6 split detector and comprises 5 DVD sensors 370a, 370b, 370c, 370d, and 370e and one single CD sensor 370f. The DVD sensors and the CD sensor are arranged apart from one another by a predetermined distance d' from a center to a center. The predetermined distance d' is obtained by taking into consideration optical characteristics, such as a gap between the DVD light source and the CD light source and thickness/location/angle of the light beam splitter 310. For example, the predetermined distance d' is proportional to the thickness of the light beam splitter 310.

The first sensor 370a and the fifth sensor 370e of the DVD sensor detect signals corresponding to the first and the fifth beams, the second sensor 370b and the fourth sensor 370d detect signals corresponding to the second and the fourth beams, and the third sensor 370c detects a signal corresponding to the third beam. When the second light source is operated for the reproduction of the CD, the sixth sensor 370f detects a signal of beams emitted from the second light source.

The signals detected by the respective sensors of the photodetector 370 are used to perform a servo control. The servo control is divided into a focus servo control for focusing

the light rays on a reading system embedded in a DVD player and a tracking servo control for maintaining a constant position of the disk. The focus servo control is to control a focal point of light rays on a recording surface of the disk, while the tracking servo control is to control such that the pickup is always located at a constant position to prevent the focal point from being deviated from a pitch line.

The optical disk 400 has a different thickness and a different pitch gap depending on the kind of the optical disk 400. A servo control method in recording/reproducing data is also different depending on the kind of the optical disk 400. When a DVD-ROM disk is used for the optical disk 400, it generates a focusing error (FE) signal by the astigmatism method and generates a tracking error (TE) signal by the DPD (Differential Phase Detection) method. The FE signal and the TE signal are obtained from a signal of the third beam detected by the third sensor 370c.

If a DVD-RAM disk is used for the optical disk 400, it generates a FE signal by the DAD method and a TE signal by the DPP or the PP (Push Pull) method. The FE signal and the TE signal are obtained from signals of the first, third and fifth beams detected by the first, third and fifth sensors 370a, 370c, and 370e.

If a DVD-R and a DVD-RW disks are used for the optical disk 400, a FE signal is calculated by the astigmatism method and a TE signal is calculated by the DPP method. The FE signal is included in a signal of the third beam detected by the third sensor 370c and the TE signal is obtained from signals of the second, third and fourth beams detected by the second, third, and fourth sensors 370b, 370c and 370d.

If a CD is used for the optical disk 400, a FE signal is calculated by the astigmatism method and a TE signal is calculated by the PP (Push Pull) method. The FE signal and the

TE signal are obtained from a signal of the beams detected by the sixth sensor 370f.

The actuator adjusts the object lens 350 in response to the FE and TE signals generated from the respective disks, and performs the servo control.

In the above-described embodiment, the optical pickup apparatus is capable of recording/reproducing with respect to the DVDs having different formats, and it is capable of reproducing only with respect to the CD. However, if a hologram module for CD is employed and a structure of the photodetector and a tracking method thereof are changed, the CD is recordable.

[Mode for Embodying the Invention]

[Reference List]